(19) Europäisches Patentamt
Europ an Pat nt Office
Office européen d s brev ts

(11) Publication number: **0 277 505 B1**

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **22.04.92** (51) Int. Cl.5: **A61L 2/10**

(21) Application number: **88100402.2**

(22) Date of filing: **13.01.88**

(54) **Apparatus for sterilization with ultraviolet light.**

(30) Priority: **14.01.87 JP 7299/87**

(43) Date of publication of application:
10.08.88 Bulletin 88/32

(45) Publication of the grant of the patent:
22.04.92 Bulletin 92/17

(84) Designated Contracting States:
DE FR GB SE

(56) References cited:
EP-A- 0 143 856
GB-A- 1 093 751
GB-A- 2 155 625

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in FIGURE 2; and

FIGURES 4 and 5 show schematically tw con- v ntional art apparatus for effecting sterilization with ultraviolet light.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

An embodiment of the present invention is hereinafter described with reference to Figs. 1 to 3, in which like reference numerals represent like parts throughout.

As shown in Fig. 1, a mercury-vapor xenon arc lamp 21 is connected to a power supply circuit 22 which supplies power for light emission. The lamp 21 is surrounded by a reflector mirror 23 having a generally elliptical inner surface. A light guide 24 is positioned ahead of the lamp 21. One end surface of the light guide 24 which serves as a light receiving surface 25 is positioned in a face-to-face relationship with the reflector mirror 23, while the other end surface of the light guide 25 which serves as a light emerging surface 26 is directed toward an object to be sterilized (not shown).

Ultraviolet light eminating from the mercury-vapor xenon arc lamp 21 is reflected by the mirror 23 and concentrated at the receiving end surface 25 of the light guide 24. Ultraviolet radiation having a desired wavelength in a range of from 200 to 300 nm (for example, 254 nm) may be selectively reflected from the mirror 23 if the reflecting surface of the mirror 23 has a coating of a multilayered dielectric.

The ultraviolet light incident on the receiving end surface 25 of the light guide 24 propagates through it and emerges from the exit end surface 26. Since the light guide 24 has optical fibers which may be bundled together, the ultraviolet light emerging from the light guide can be directed to a desired position. The light guide 24 is also easy to handle since it can be designed to have a small diameter. It is also, however, rugged in structure.

Various modifications can be made to the apparatus shown in Figure 1 for instance, in addition to a mercury-vapor xenon arc lamp, many other ultraviolet light sources can be used such as a high pressure mercury-vapor lamp, an ultra high-pressure mercury-vapor lamp, and a microwave discharge lamp. High-pressure mercury-vapor lamps and mercury-vapor xenon arc lamps typically emit radiations having wavelengths between 180 and 2,000 nm but, in terms of radiant intensity ($\mu W/cm^2$), they produce strong spectrum lines at such wavelengths as 365, 405, 436, 546 and 577 nm. Therefore, thes lamps ar generally employed as light sourc s of near ultraviolet radiations. Howev r, they also produce spectrum lin s of low relative intensity in the far ultraviol t region centered on a wav length of 254 nm. In addition, the absolut valu of radiant intensity at 254 nm is sometimes gr at r than what is produced by ordinary low-pressure mercury-vapor lamps. Therefore, ultraviolet radiation having a wavelength of 254 nm can be effectively used for the purpose of the present invention by selectively reflecting said radiation from the mirror 23.

A low-pressure mercury-vapor lamp can also be used as an ultraviolet lamp, but this lamp has the disadvantage that light issuing therefrom is not easy to concentrate in the light guide with high efficiency because it has a large surface area and produces a low radiant intensity, however it does produce high radiant energy.

As for the reflector mirror 23, one which has an ellipsoidal shape may be used if the ultraviolet lamp is close to a point source in nature such as a high-pressure mercury-vapor lamp or a mercury-vapor xenon arc lamp. If a microwave discharge lamp in a rod shape is used as an ultraviolet lamp, it may be combined with a columnar mirror having a elliptical cross section and a substantially linear longitudinal section. In this case, the trough-shaped mirror is positioned so that its axis is parallel to that of the rod-shaped lamp.

In order to achieve selective reflection of ultraviolet radiation having a predetermined wavelength, the reflector mirror 23 may be coated with several tens of dielectric layers each having a thickness of a quarter of the wavelength. Suitable materials for this dielectric coating include Al_2O_3/NaF, Sc_2O_3/MgF_2, ThF_4/Na_2AlF_6, HfO_2/SiO_2, and PbF_2/Na_3AlF_6. If desired, the multilayered dielectric coating may be replaced by an aluminum coating. The ultraviolet radiation is not limited to one having a wavelength of in a range of 200 to 300 nm (particularly 254 nm) but may be changed to various wavelengths depending upon the emission spectrum of the ultraviolet lamp used or the absorption spectrum of the object to be sterilized.

The optical fibers in the light guide may have a pure quartz core. Ordinary optical fibers having a core containing germanium oxide suffer from great loss in transmission of wavelengths of 400 nm and below and hence are not generally suitable for use in the embodiment under discussion. However, ultraviolet optical fibers produced by Sumitomo Electric Industry Ltd. (MS and BS series) can be used for commercial applications of the present invention since a length of 1 m of such fibers is capable of transmitting at least 85% of an ultraviolet radiation at a wavelength of 254 nm.

Light guide 24 may employ a bundle of 475 optical fibers having a core diam ter of 180μm. Alternatively, a single optical fiber having a core diameter of 0.8 mm may b us d to concentrate ultraviolet light on a small area. In th embodiment

mercury-vapor lamp.

3. A sterilization apparatus according to claim 1 wherein said ultraviol t lamp is a mercury-vapor xenon arc lamp.

4. A sterilization apparatus according to claim 1 wherein said ultraviolet lamp is an ultrahigh-pressure mercury-vapor lamp.

5. A sterilization apparatus according to claim 1 wherein said ultraviolet lamp is a microwave discharge lamp.

6. A sterilization apparatus according to claim 1 wherein said reflector mirror has a coating of a multilayered dielectric film.

7. A sterilization apparatus according to claim 1 wherein said reflector mirror has an aluminum coating.

8. A sterilization apparatus according to claim 1 wherein said reflector mirror is capable of selectively reflecting an ultraviolet radiation at a wavelength of in a range of from 200 to 300 nm.

9. A sterilization apparatus according to claim 8 wherein said reflector mirror is capable of selectively reflecting an ultraviolet radiation at a wavelength of 254 nm.

10. A sterilization apparatus according to claim 1 wherein the optical fibers in said light guide have a pure quartz core.

Revendications

1. Appareil de stérilisation par lumière ultraviolette comprenant : une lampe à rayons ultraviolets (21) ; caractérisé en ce qu'il comprend en outre un guide de lumière (24) comportant des fibres optiques, ledit guide de lumière comprenant une surface d'extrémité de réception (25) et une surface d'extrémité de sortie (26) ; et un miroir réflecteur (23) qui réfléchit une longueur d'onde prédéterminée du rayonnement ultraviolet qui provient de la lampe à rayons ultraviolets et qui concentre le rayonnement réfléchi au niveau de la surface d'extrémité de réception dudit guide de lumière, la lumière qui émerge d la surface d'extrémité d sorti dudit guide de lumière étant dirigé sur un objet qui doit être stérilisé.

2. Appareil d stérilisation selon la r vendication 1, dans lequel ladite lampe à rayons ultraviolets st une lamp à vapeur d m rcur haute pr ssion.

3. Appareil de stérilisation s lon la r vendication 1, dans lequel ladite lampe à rayons ultraviolets est une lampe à arc à xénon et vapeur de mercure.

4. Appareil de stérilisation selon la revendication 1, dans lequel ladite lampe à rayons ultraviolets est une lampe à vapeur de mercure à ultra-haute pression.

5. Appareil de stérilisation selon la revendication 1, dans lequel ladite lampe à rayons ultraviolets est une lampe à décharge micro-ondes.

6. Appareil de stérilisation selon la revendication 1, dans lequel ledit miroir réflecteur comporte un revêtement constitué par un film diélectrique multi-couches.

7. Appareil de stérilisation selon la revendication 1, dans lequel ledit miroir réflecteur comporte un revêtement en aluminium.

8. Appareil de stérilisation selon la revendication 1, dans lequel ledit miroir réflecteur peut réfléchir de manière sélective un rayonnement ultraviolet à une longueur d'onde qui se situe dans une plage qui va de 200 à 300 nm.

9. Appareil de stérilisation selon la revendication 8, dans lequel ledit miroir réflecteur peut réfléchir de manière sélective un rayonnement ultraviolet à une longueur d'onde de 254 nm.

10. Appareil de stérilisation selon la revendication 1, dans lequel les fibres optiques contenues dans ledit guide de lumière comprennent une âme en quartz pur.

Patentansprüche

1. Eine Vorrichtung zum Sterilisieren mit ultravioiettem Licht, welche eine Ultraviolettlampe (21) umfaßt; **dadurch gekennzeichnet,** daß die Vorrichtung ferner eine optische Fasern aufweisende Lichtführung (24), wobei die Lichtführung eine Empfangsendoberfläche (25) und eine Ausgangsendoberfläche (26) aufweist; und einen Reflektorspiegel (23) umfaßt, welcher eine vorbestimmte Wellenlänge der ultravioletten Strahlung aus der Ultraviolettlampe reflektiert und die refl ktierte Strahlung auf der Empfangs ndob rfläche der Lichtführung konzentriert, wobei das aus der Ausgangsendoberfläche der Lichtführung austretend Licht auf

FIG. 1

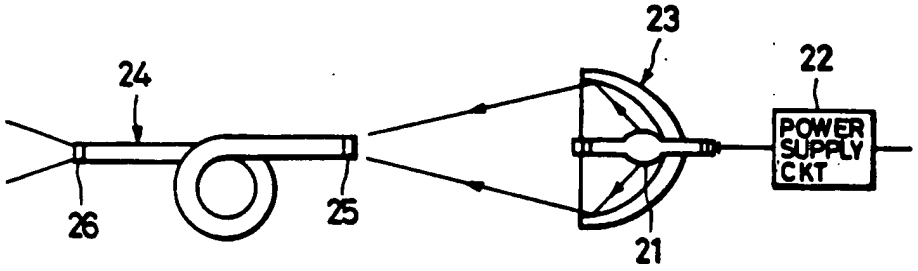


FIG. 2(A)

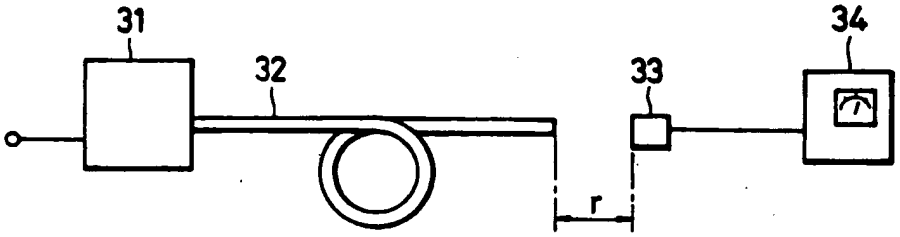


FIG. 2(B)

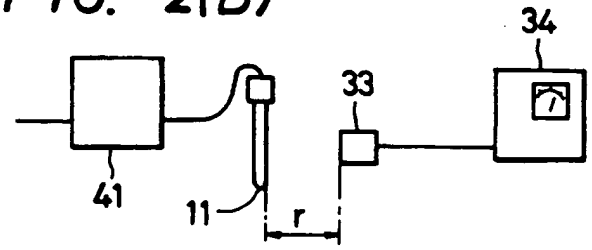


FIG. 4
PRIOR ART

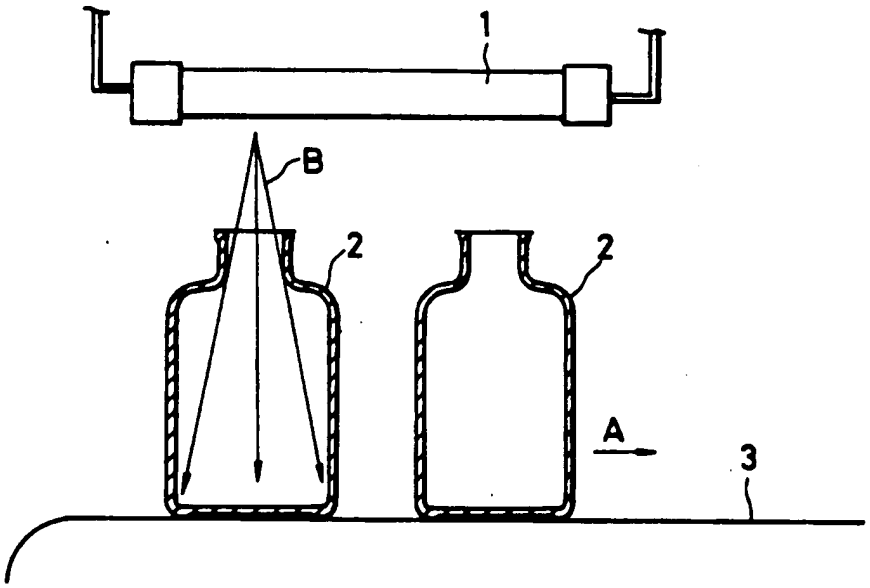
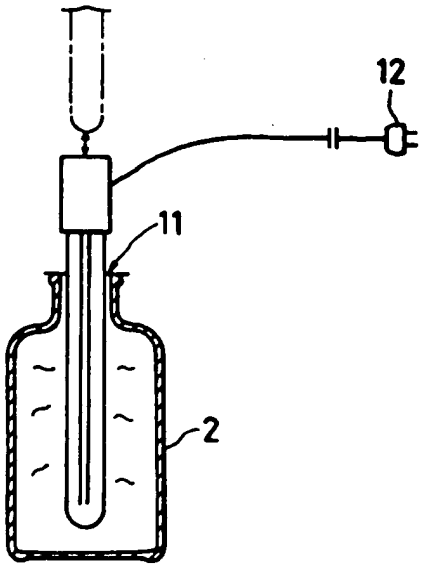


FIG. 5
PRIOR ART



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